Ground Communications Facility System Tests

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The Ground Communications Facility substantially upgraded the High-Speed System and implemented a new Wideband System for more comprehensive operational data transfers. Extensive tests were conducted prior to turning these systems over to operations personnel for integration into the Deep Space Network (DSN). This article summarizes the purpose and results of these tests, with the final objective of full committed support of Mariner Mars 1971 flight operations.

I. Introduction

The functional design requirements established by the Deep Space Network (DSN) for the necessary capabilities to support the *Mariner* Mars 1971 flight operations included specific items pertaining to the communications services from the tracking stations and the operations and data processing areas at JPL. Much of the required capability existed, yet much had yet to be engineered, installed, and operationally verified. (See Refs. 1, 2, 3, and 4.)

During 1970, the Ground Communications Facility (GCF) concentrated on two major changes to the Facility: (1) the conversion of the High-Speed Data System from 2400- to 4800-bps operation, and (2) the implementation of a Wideband System 50-kbps digital transmission capability. These developments have been completed and tested on a system basis.

The system tests were conducted to verify that the system operated properly and that it met the functional requirements which it was designed to satisfy. These tests also validated the design and exercised the proposed operational procedures. Though the system tests measured the overall bit error rates, detailed error statistics tests are being conducted and will be reported in future articles.

II. High-Speed Data

The upgraded high-speed data capability provides a single-channel full-duplex 4800-bps terminal at each Deep Space Station (DSS) and the Compatibility Test Area (CTA 21), as well as 3 channels in the Simulation Center (SIMCEN) and 6 channels in the SFOF Communications Terminal. Each DSS is connected to the Space Flight Operations Facility (SFOF) via transmission paths consisting of discrete links between major NASCOM switching centers and the end link to the DSS. At each NASCOM center, full-duplex regeneration capability is provided.

In every case, tests were conducted between each DSS and the SFOF, the test series being extended when anomalies were encountered. The stations were tested in the following chronological order, beginning in October

1970: DSSs 12, 41, 51, 62, 71, CTA 21, SIMCEN, and DSSs 14 and 11. DSSs 42 and 61 will be tested in April 1971.

It was originally intended to use a special test program which would exercise the interfaces between the GCF and Deep Space Instrumentation Facility (DSIF) and between the GCF and SFOF in addition to providing performance data on all installed equipment and operational circuits. However, unforeseen delays in the test program development and debug, as well as the availability of necessary machine time, required an alternative test sequence to be developed and used. This enabled all GCF equipment, procedures, and circuits to be checked out up to the DSIF interface. A separate test series validated the interface at the SFOF.

A number of discrepancies were discovered and rectified before acceptable all-around performance was obtained. Among the most notable of the discrepancies were:

(1) A severe impulse noise cross talk into Australian circuits between DSS 41 and Canberra Switching Center causing high error rates. This was subsequently cleared by the common carrier, after being found to be in Woomera Village. High-level dialing pulses were the prime cause of the problem.

(2) Early high error rate from DSS 51 due to lack of regeneration equipment at Ascension was improved into acceptable limits after regeneration became operational.

(3) Line level problems at Madrid Switching Center and DSS 62 delayed final acceptable test.

(4) In-house equipment installation delays at DSS 71 caused schedule slippage.

Other minor hardware discrepancies were also revealed at various locations and certain items of test equipment were found to be inadequate for the required tests. All such items were restored to a full operational condition.

The operational activation and use procedures were adjusted as a result of this test series and all personnel training was determined to have been sufficient.

Generally speaking, better than 99% of all transmitted data blocks (each block is 1200 bits) were received without error.

III. Wideband Data

The new wideband data capability provides 50-kbps terminal equipment at four locations: the SFOF, the Simulation Center, CTA 21, and DSS 14. Transmission paths connect each of the outlying locations to the SFOF.

Five tests were conducted, one for each of the functional paths:

(1) CTA 21 to SFOF.

(2) Simulation Center to SFOF.

(3) Simulation Center to CTA 21.

(4) DSS 14 to SFOF.

(5) Simulation Center to DSS 14.

These tests were conducted in November and December 1970 in accordance with a sequence-of-events. The tests exercised the end-to-end system between the GCF interface points. The tests did not exercise the DSIF nor the SFOF's interfacing equipment, since the other sides of these interfaces were not yet complete or were not yet cabled to the interface point. All GCF-furnished cables were tested to the distant connector.

The test results were satisfactory, though some minor discrepancies were revealed. Some jack panels were not labeled and one reversed connector shell was found. An ancillary test function would not operate properly, and an output converter was found to be inoperable. Some other minor hardware difficulties were revealed. The tests disclosed that several of the operating procedures were not appropriate. Training was also found to be inadequate in some cases.

The error rate tests showed a bit error rate of 7×10^{-7} for five tests totaling 14.4 hours. During three of the tests between CTA 21, the Simulation Center, and the SFOF, no errors were detected during 6.8 hours of activity. In a separate 6.5-hour test from DSS 14 to the SFOF, 99.97% of the 1200-bit blocks were received error-free.

All equipment discrepancies were cleared subsequent to the tests, and additional training was given. In order to provide familiarity with the equipment and the procedures, the DSS 14–SFOF circuit activation procedure was repeated weekly.

IV. Conclusion

The High-Speed and Wideband System tests detected some equipment problems, revealed inadequacies in the

proposed operating procedures, and produced accurate data on gross error rates. These tests were of direct and substantial benefit to the GCF. Similar tests will be conducted on future GCF system developments; however, such future tests will be designed to more fully exercise the interfaces in order to detect this type of problem at an earlier stage.

The 4800-bps and 50-kbps capabilities are now in the DSN's operational inventory.

References

1. McClure, J. P., "Ground Communications Facility Functional Design for 1971–1972," in *The Deep Space Network*, Space Programs Summary 37-66, Vol. II, pp. 99–102. Jet Propulsion Laboratory, Pasadena, Calif., Nov. 30, 1970.
2. Nightingale, D., "High-Speed System Design Mark IIIA," in *The Deep Space Network*, Space Programs Summary 37-66, Vol. II, pp. 103–105. Jet Propulsion Laboratory, Pasadena, Calif., Nov. 30, 1970.
3. Evans, R. H., "High-Speed Data Block Demultiplexer," in *The Deep Space Network*, Space Programs Summary 37-66, Vol. II, pp. 105–106. Jet Propulsion Laboratory, Pasadena, Calif., Nov. 30, 1970.
4. Hanselman, R., "Wideband Digital Data System Terminal Configuration," in *The Deep Space Network*, Space Programs Summary 37-66, Vol. II, pp. 107–110. Jet Propulsion Laboratory, Pasadena, Calif., Nov. 30, 1970.